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Fabrication Effects on the Morphology and Electronics in Organic Photovoltaic Solar Cells

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Developing novel organic photovoltaic (OPV) devices is important as demands for energy increase. The main obstacle in conventional OPVs is the low efficiency at ~6%, far below what requires for commercial applications. We have studied the morphology of a group of polymers that contain alternating units of thieno[3,4-b]thiophene and benzodithiophene units (denoted PTB), which was done in collaboration with Luping Yu at the University of Chicago. We have shown through grazing incidence x-ray scattering techniques that these polymers do in fact have an optimal packing structure for solar cell devices compared to more conventional polymers used in OPV devices. The highest solar cell efficiency observed in these materials is 8%, which is the current record efficiency to our knowledge. We have also focused on the role that aliphatic side chains play in the optoelectronic and morphological properties in these polymer systems. In this work, the spectroscopic, x-ray, and kinetic characteristics of seven PTB polymers are discussed in detail. Although these polymers differ by their side chains, the PTB backbone is the same in all polymers. Slight structural changes elucidate the electronic and morphological characteristics that make these polymers ideal for OPV devices.